



Silken strands

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SILKEN STRANDS: MAKING TECHNOLOGY WORK IN CHINA

Dagmar Schäfer

In 1371, only three years after proclaiming his reign, Zhu Yuanzhang 朱元璋 (1328–98, reign Hongwu 1368–98) founder of the Ming dynasty, turned his hand to the organization of material production within his empire. This entailed the employment of artisans and installation of workshops at the court, and the set-up of governance structures for the management of public works. In addition, in some trades such as silk and porcelain, the Ming founder initiated spatially distributed networks of state-owned workshops. In the case of silk this network consisted of twenty-three workshops located in the provinces of Zhejiang, Nanzhili, Fujian, Jiangxi, Sichuan, Henan and Shandong. The geographical scope was unprecedented and the structure innovative: unlike the Song and Yuan states who usually incorporated local expertise, the Ming state assigned each workshop a specific set of products. And whereas the Song and Yuan rulers intruded on the localities in a rather ad hoc manner, the Ming founder, Zhu Yuanzhang, established quotas and stabilized production. Consolidating tasks and numbers, he institutionalized complex channels of communication through which craft work, both on the managerial and the technical level, was transmitted.

This article scrutinizes the Chinese concepts and modalities of practical knowledge transmission that informed state models of craft production. My main example is silk manufacture: a complex socio-technical system involving core issues of the Chinese world. Silk was part of ritual and rulership, diplomacy and philosophical discourse, luxury consumption and everyday needs. The Ming dynasty is my central focus, my basis for comparison when I look at the grand schemes of various eras, Song, Yuan, and Qing, to trace changes in the basic conditions for technological production.¹ The thematic concern of this article lies in the technical side of communication, that is, how actors and agents created channels and packaged and conveyed information to make production work.² The mobility of artifacts and people, both geographically and socially

¹ The main issues of the larger changes are evident in microcosm if one looks closely. The seven phases identified by Sarah Schneewind, for example, as crucial for the institutionalization of village administration during the Hongwu reign, are thus relevant for technical developments and craft production, in particular with regard to the local organization of levy; Sarah Schneewind, “Visions and Revisions: Village Policies of the Ming Founder in Seven Phases,” *T'oung pao* 87, no. 4–5 (2001).

² Social or ritual practices also apply, but their discussion goes beyond the scope of this article.

are undercurrents to this theme. I delineate three aspects: first, I identify elements of the root architecture, then in a second step, the signals and carriers these actors thought useful to convey practical knowledge are described. The third and final part concerns the channels, the pathways, wavelengths and social bandwidths through which knowledge could circulate.

Historical materials, both written and artifactual, convey the message that dynastic rulers envisioned practical knowledge communication quite differently. While the Song state, for example, exerted a liberal attitude and believed in self-regulation, the Yuan state decreed craft professions be kept within familial structures to secure the diachronic transmission of know-how. Socializing craft manufacture, all dynastic houses relied on local tax surveying structures and dispatched confidants, either court eunuchs or central state officials, to make special demands. In part the Ming state drew on trends and traditions established by the Song and Yuan states. But the Ming dynasty's approach to communication was much more comprehensive. Concerned about the flow of information, the Ming founder Zhu Yuanzhang institutionalized a broad spectrum of paperwork: memos, reports, delivery notes, routine requests and demands; which, taken together, document attitudes to practical knowledge circulation. In most cases this official documentation exposes the state's efficient enactment of the modes of transmission. But when it emphasizes difficulties in meeting quotas or deadlines, this documentation verifies that Ming officials at all hierarchal levels as well as private scholars were conscious of the fact that knowledge circulation in fields of practical engagement was not a trivial matter. Actors, craftsmen as well as civil servants, pointed to the tacit component of craftwork to explain and excuse shortcomings. Observers, scholars as well as politicians, discussed how to enhance artisanal mobility and make effective use of written documentation. The people in power at the top levels of administration were well aware that successful silk production required the cooperation of all actors and agents involved.

The first emperor of the Ming, Zhu Yuanzhang, carefully allotted responsibilities to either the craftsman or the official, the workshop and local, regional or central state administration so that experience could grow and stabilize on each level, while a system of regular reports ensured the vertical information flow. The officials' prime duty was to give a full account of all relevant features of supply, production, and delivery. Standards and quotas for raw material, labor and end products brought about permanence and economized information flow. For the horizontal flow of managerial skills he considered written transmission useful. He conceived carefully organized schemes of levy to ensure the circulation

of technical know-how. Institutional structures were also designed to enhance transmission across hierarchies. Artisanal foremen and low-level regional officials, knowledgeable about local conditions and experienced in the details of silk production, were the informants of a fluctuating group of regional supervisors who traveled the country to implement general standards and unify regulations. On paper, the Ming model was consummate, designed to facilitate information flow up and down the silk production network. Clearly the design affected the recognition of craftsmen as a group. Drawing artisanal work into the remit of his officials – men who based their identity on scholarly knowledge – Zhu strengthened technology's role in Chinese society and state, and at the same time installed a system that allowed the elite to keep the artisan an arms length away from social and political power and historical appearance. Scholarly writing and administrative account reflect this tension as they describe the overall texture and identify significant patterns. These writings give refined insights into the formal and informal communicative features that, as tenuous and resilient as silken strands, fixed the weft of technological production in imperial times.

Root architecture: Silk production and state interference from the tenth to eighteenth century

Silk production in dynastic China took place in four different fields: (1) the government (both in the civil and military sector), (2) in private family households, (3) in commercial workshops and (4) within religious structures in temples and monasteries. Our knowledge about all four fields, their individual performance and interaction varies according to the degree to which they were attached to written documentation and archaeological research focus. Documentary depth improves with the relation to political power and social concerns. State production thus features prominently, although we know in reality that household production, while rarely touched on in writings, was the basis of the goods market and crucial for the functioning of state enterprise. Religious structures, monasteries and temples, lost their importance as silk producing units after the ninth century (that is the Tang era during which emperors had occasionally provided monasteries with land and rights).³ When the Northern Song state began to be more systematically involved in silk production, it drew

³ Dieter Kuhn, *Textile Technology*, pt. 9 of *Chemistry and Chemical Technology*, vol. 5 in *Science and Civilisation in China*, ed. Joseph Needham (Cambridge: Cambridge University Press, 1988) and Bray, *Technology and Gender*.

either from expertise in rich landed estates, or urbanized elite households which often hosted large workshops with more than one hundred (female) workers producing high quality silk for use of the elite and the state on complex draw looms with pattern towers. Farmers' households, in stark contrast, usually owned only one or two looms of simple construction. They produced low-quality tax silk (*juan* 絹) on a subsistence level. Occasionally, craftsmen and merchant families built up larger workshops with hired personnel beyond family boundaries.

How did actors of this era actually communicate issues of production, technology and design on the practical level? Central to the production of complicated silks used for ritual gowns, for example, were the weavers (*jigong* 機工, *zhigong* 織工) and the pattern masters (*tihua zi* 提花子) who translated the complex designs of five-colored brocades and damask, or the sophisticated patterns of dragon robes into the complicated mechanisms of the draw loom with pattern tower. Sources imply that during the Song, Yuan and Ming eras these two groups translated the pattern freehanded onto the machine and into the warp and weft. The necessary technical translation was done by hand while weavers and pattern masters communicated and memorized procedural technical details in the form of riddles or chants. Knowledge circulated through oral pathways, and probably by visual and material means, that is, through paintings, or samples, of which we have only traces of evidence.

The regulation of communication is concerned with more than pragmatics. It is also a question of power and thus the chosen method divulges historical perspectives on the relation between power and abilities: to what extent did actors control the execution of production? In writings, for example, state and society insisted on the correct execution of patterns and colors, paying respect to the function of clothing as status symbol. Scholars and state carefully watched and noted any changes in habits and insisted on the proper execution of their ideals.⁴ An important issue lingering behind the actual communication method and means is furthermore the question of efficiency. While person-to-person circulation efficiently communicates the tacit dimensions of craft knowledge, by which

⁴ This explains the great concern of statesmen such as Qiu Jun (1418–95) on textile manufacture; Qiu Jun 邱濬, *Daxue yanyibu* 大學衍義補 [Supplement to the explanations of the great knowledge] (Taipei: Shijie shuju, 1988 [1506]). Zujie Yuan, "Dressing for Power: Rite, Costume, and State Authority in Ming Dynasty China," *Frontiers of History in China* 29, no. 2 (2007). For the costume regulations of the Ming see Li Dongyang 李东阳, *Da Ming huidian* 大明会典 [Collected statutes of the Ming dynasty] (Taipei: Dongnan shubaoshe, 1963 [1587]), chap. 61; Zhang Tingyu 張廷玉 et al., eds., *Mingshi* 明史 [History of the Ming] (Beijing: Zhonghua shuju, 1957), 66: 42.2 (1622), 67: 43.3 (1633–1634).

I mean embodied skills and practices, its sphere of influence is limited. This, on the one hand, facilitates control, yet, on the other hand, enhances the power of the individual.

The use of illustrations, auxiliary tools, or technical drawings of designs, might have had its limits as a method of practical knowledge circulation, but it gave power to the manager in craft production.⁵ It also enabled other forms of work organization, as research by Sarah Fraser on Dunhuang wall paintings has shown: very early workshops employed sketches to economize labor and materials in modular design.⁶ We also have it on record that Song, Yuan and Ming actors, in state administration and private enterprises, occasionally resorted to storage devices, such as models, or transmitted tools such as rulers or compasses for the communication of design and technical issues in carving and ceramic works, in the construction of astronomical instruments or when planning architecture. Emperors, and officials, the state and elites, regularly asked for the reproduction of popular motifs from one media into another: stone carvings served as samples for paintings, and illustrations and calligraphy were translated into embroidery or woven cloth or vice versa. This included, as Angela Sheng has shown, the appropriation of “foreign” motifs in silk weaving.⁷ Up until now, however, historical research holds that no state before the Ming used such methods and mediums systematically for the transmission of technical and design issues, neither within state-owned silk manufacture nor for interaction with private workshops. In its relation to state power, knowledge circulation in silk production hence mainly relied on the regulation of personal contacts through the organization of artisanal migration.

Archival records and artifactual evidence confirm the Qing rulers made systematic use of storage devices. Court painters, for example, sketched designs for robes before production took place. After imperial approval, selected clans of bannermen delivered the sketches to the regional workshops (Suzhou, Hangzhou or Nanjing) for production. The finished and delivered product would again be compared to the sketch to verify

⁵ An insightful view into the varying styles and purposes of printed illustrations, from diagrammatic philology to decorative paint is provided in Bray, Dorofeeva-Lichtmann, and Métaillé, eds., *Graphics and Text in the Production of Technical Knowledge in China*.

⁶ Sarah Fraser, “Formulas of Creativity: Artist’s Sketches and Techniques of Copying at Dunhuang,” *Artibus Asiae* 59, no. 3–4 (2000).

⁷ Angela Sheng, “The Disappearance of Silk Weaves with Weft Effects in Early China,” *Chinese Science* 12 (1995).

correct execution of the order.⁸ Can we assume that the Ming dynasty used similar methods? Probably not; during the Ming period, emperors and scholars had full confidence in their rights to silk and their knowledge about it. They felt in line with a cultural tradition when they used the symbols and styles of clothing of their predecessors as a symbol for social status and political power. The Ming rulers relied on their hegemonial power and rights when they exerted pressure on artisanal production in their Southern provinces. And even if regional scholars and officials were sometimes corrupt, the Ming state could rely on the loyalty of its subjects far more than their successors, the Manchu rulers of the Qing dynasty. The Qing rulers had a completely different background and thus a different attitude and agenda when it came to products such as silk. Silk represented Han-Chinese culture in everyday life and state politics, as raw material and textile, not only as cloth but as a tributary ware and trade good. The style and symbolism of ritual and court gowns, for example, followed Chinese rules, and, despite untiring efforts, the Manchu rulers introduced very few native elements. This may have been a deliberate political act of acculturation on their part. But in fact, the Manchu were not technically adept enough in silk production to enforce a change.

The appropriation of silk was an ideological and political matter for the Qing who had long struggled for control of the Southern provinces where silk manufacture actually took place. These conditions produced a different culture of information. Historians of late imperial China suggest a relation between the Qing's loosening of the reins of levy in silk production and an increase in productivity, the upcoming of commercialization and a prosperous China.⁹ The heart of this move was not, however, economic liberalism, it was rather a confession of their inability to gain control over the administrative apparatus in these regions in a sector they deemed

⁸ Notwithstanding such measures, the court's supervisors, however, never complained about the variations that evidently occurred as verified by the still existing artifacts, not even in their everyday recordings or account books; Zhang Qiong 張琮, "Huangquan yu jishu: Qing dai nei zhiranju kaocha 皇權與技術: 清代內織染局考察 [Imperial power and technology: an examination of the Qing dynastic Inner Weaving and Dyeing Bureau]," in *Gongting yu difang: Shiqi zhi shiba shiji de jishu jiaoliu* 宮廷與地方: 十七至十八世紀的技術交流 [The court and the localities: technological knowledge circulation in the seventeenth and eighteenth century] (Beijing: Zijincheng chubanshe, 2010), 107–109, 11.

⁹ Fan Jinmin 范金民, *Jiangnan sichoushi yanjiu* 江南丝绸史研究 [Research on the history of silk in the Jiangnan region] (Beijing: Nongye chubanshe, 1993); Fan Jinmin 范金民 and Xia Weizhong 夏维中, *Suzhou diqu shehui jingjishi (Ming Qing juan)* 苏州地区社会经济史 (明清卷) [Economic and social history of the Suzhou region] (Nanjing: Nanjing daxue chubanshe, 1993).

essential to their rule. The Kangxi, Yongzheng and Qianlong emperors all tried diverse strategies to get themselves into the silk game. The Kangxi emperor put his trust in personal relationships.¹⁰ The Yongzheng emperor requested detailed reports. Under his rule production facilities in Suzhou and Hangzhou were continually expanded.¹¹ The Qianlong emperor, realizing he would fail to install production at the court and capital in Beijing, embarked on the symbolic value of silk production: he brought to life and idealized the Song dynastic painting of the *Gengzhi tu* 耕織圖 (Illustrations on tilling and weaving).¹² Furthermore he became increasingly involved with design, asking court painters to detail patterns, decorations and cuttings that he then approved personally before production could be initiated.

Institutional settings reveal how diversely states conceptualized knowledge circulation. The earlier Song system of state-owned silk manufacture was an emergent model and Yuan state engagements a later adjustment. In both periods, the state actors figured on the functioning of existing formal and informal structures. Communicative patterns happened and were not premeditated. In contrast, Ming administrative sources speak of an imperial attempt to institutionalize a comprehensive and full-fledged system of knowledge flow on the basis of migration. In its initial design, the system included the mediation of technical know-how, experience and skills and regulated the channels through which managerial information could and should flow, and where knowledge circulated. The Qing court then expanded the use of storage devices, controlling knowledge rather than circulating it.

Communication within early modern craft systems is essentially concerned with the chronological perspective, the geographic range and spatial organization. Let me begin with the spatial organization of labor. Apart from material and climatic conditions, state actors took into account the actual concentration of labor and expertise in silk production. The

¹⁰ For a splendid account of how the Cao family monopolized imperial textile production see Jonathan D. Spence, *Ts'ao Yin and the K'ang-hsi Emperor: Bondservant and Master* (New Haven: Yale University Press, 1966).

¹¹ Jiang Zhaocheng 蔣兆成, "Qingdai guanying Hangzhou sizhi gongye de shengchan fangshi yu jingying guanli 清代官營杭州絲織工業的生產方式與經營管理 [Management and production styles of the state-owned silk manufacture in Hangzhou during the Qing dynasty]," *Zhongguo jingjishi yanjiu* 3 (1994).

¹² This catalogue was originally painted by Lou Shou 樓璣 (1090–1162) around 1145 during the Song dynasty, and consisted of 45 leaflets. The Kangxi and the Yongzheng emperors had it copied several times. For a reproduction see Liu Lu 劉澗, "Yongzheng huangdi ban gengfu 雍正皇帝扮耕夫 [Yongzheng's distinction of peasants]," *Zijincheng* 133, no. 6 (2005).

Song and Yuan rulers hence settled state-owned workshops at the hotspots of private economy, profiting from existing local infrastructure and manpower. Early on in the Song era, local officials interfered in existing markets (*chang* 場) for silk by increasing the control mechanisms at tax collecting stations (*wu* 務). Then they expanded these tax collecting stations to halls (*yuan* 院) that organized everything from recruiting the work force and raw materials for silk production to the transportation of the end products to its final destination. By the mid-tenth century, such halls in the Jiangnan region had taken over the responsibility for production. Some did general tasks, others specialized in wadding or weaving, filature, spinning and reeling threads or concentrated solely on dyeing.¹³ Until the eleventh century, probably even the fourteenth century, Sichuan province, where the brocade loom with footplates was invented and used, represented the most technically advanced region in silk production.¹⁴ Another traditional centre for processed silk was the lower Yangtze region. Increased political instability made the Northern Song dynasty move silk production nearer to its capital Kaifeng. The state invested into silk manufacture in the Northern Zhili 直隸 area. With the loss of their Northern territory in 1127, the Song state moved silk manufacture south to the area around their capital Hangzhou. At the same time the Jurchen (Nüzhen 女真) Jin dynasty and the subsequent Yuan-Mongols in the North of China attempted to sustain an independent silk producing network of their own in the Nanzhili area (modern Jiangsu and Anhui).¹⁵ Official documentation suggests both states acted independently. During the Yuan dynasty, Sichuan regained some of its independence while the production north and south of the Yangtze merged, spanning a cohesive region from Southern Zhejiang to Jiangning provinces (Nanjing). Economic needs, war and state power enforced migrational patterns for the farmers and artisans and the

¹³ Ma Duanlin 馬端臨 (1254–1323), *Wenxian tongkao* 文獻通考 [Comprehensive examination of literature] (Beijing: Zhonghua shuju, 1986) chap. “Zhengque yi 征榷— [Taxes and fees],” 14: 148 describes the institution of markets (*chang* 廠). All other organizational units are described in detail in chap. “Shidi 市糶 [Markets],” 20: 196–200. For reference see also Tuotuo 脫脫, *Song shi* 宋史 [History of the Song dynasty] (Beijing: Zhonghua shuju, 1975), “Shihuo zhi shang 食貨志上 [Food and commodities, part one],” 175: 4231–4232.

¹⁴ Dieter Kuhn, *Zur Entwicklung der Webstuhltechnologie im alten China* (Heidelberg: edition forum, 1990), 75–76, 90–97.

¹⁵ Although some research has been done on the political implications of silk trade during this period, not much has been done on the effects this disruption had on the silk manufacture.

Nanzhili and Zhejiang areas eventually took over Sichuan's leading role in silk manufacture.¹⁶

Centralized control marks the state institutionalization of silk manufacture from the tenth to the fourteenth century. Each workshop was connected to the center. The regional workshops rarely communicated with each other. Workshops drew from different resources and completed tasks independently. Regional sites fabricated an idiosyncratic panoply of local products, such as Shu brocade (*Shu jin* 蜀錦) in Chengdu and sheer gauze (*shaluo* 紗羅) in Suzhou.¹⁷ The renowned brocade office (*jinyuan* 錦院) during the Song period procured an annual tribute of high quality silk for official robes, salary silk and brocade for the court, with state institutions administering the production process rather than interfering with the production itself.¹⁸ Only the state-owned workshops located in the Song capitals (Kaifeng during the Northern Song, and Hangzhou during the Southern Song), were set up to satisfy ad hoc imperial and courtly demand. Here the range varied from requests for quite simple plain white silks to the production of custom designed items.¹⁹

The Song state thus reacted to the spatial formation of the silk network, and did not actively shape it. It profited from informal channels of transmission but did not form them. Both of these characteristics were to change with the advent of the Ming state. When Zhu ascended the throne in 1368, he could simply take over and build on the twelve institutions with 38 production sites originally installed by the Yuan emperor Kublai

¹⁶ Kuhn, *Age of Confucian Rule*; Bray, *Technology and Gender*.

¹⁷ Largely detached from the rest of the country and situated at the margin of the state, Sichuan constituted a center of silk production during the Northern and Southern Song, cultivating a rather independent system of production within their provincial borders; Li Tao 李燾 (1115–84), *Xu zizhi tongjian changbian* 續資治通鑑長編 [Expanded version of the continuation of the comprehensive mirror for aid in government], ed. Huang Yizhou 黃以周 (Shanghai: Guji chubanshe, 1986), vol. 3, 338: 1b, 2a.

¹⁸ Fei Zhu 費著 (Yuan dynasty), *Shu jin pu* 蜀錦譜 [Monograph on the brocade of Shu], *Wenyuange siku quanshu* 文淵閣四庫全書 (Taipei: Shangwu yingshuguan, 1983), chap. 4: 6a; Lu Dafang 呂大防, “Jinguan louji 錦官樓記 [Scriptures from the Hall of Brocade Officers],” in *Quan Shu yiwen zhi* 全蜀藝文志 [Complete collection of poetry and literature from Sichuan], ed. Zhou Fujun 周復俊, *Wenyuange siku quanshu* 文淵閣四庫全書 (Taipei: Shangwu yingshuguan, 1983), 34: 12b.

¹⁹ Zhang Dexiang 章得象 (979–1048) et al., *Song huiyao [jigao]* 宋會要[輯稿] [Documents pertaining to matters of state in the Song dynasty], ed. Xu Song 徐松 (1781–1848) (Beijing: Zhonghua shuju, 1957), “Zhiguan 職官 [Officials],” 36: 12a–12b, “Shihuo 食貨 [Food and commodities],” 64: 21a. Silk was, according to this document, manufactured under state auspice in the districts: Luoyang, Zhending, Daming, Qingzhou, Yizhou, Zizhou, Jiangning, Runzhou, Changzhou, Tanzhou, and Huzhou; and the cities: Hangzhou and Kaifeng.

Khan and his officials.²⁰ Up until 1426, state-owned manufacture was concentrated in the areas of Zhejiang and Nanzhili, based on traditional social structures and established patterns of transmission.²¹ Unlike its predecessors, the Ming state organized local and central production within a cohesive centrally organized web of shared resources and tasks. Central and local institutions cooperated on administrative tasks, and regulated demands and needs. Officially the court and the ruler could access the silk network only via the ministries and not directly (a regulation the third Ming emperor, Yongle, occasionally undermined by dispatching eunuchs with special requests). The Hall for Ritual Silks (Shenbo tang 神帛堂) bureau situated in Nanjing, the prior capital of the Ming, produced silk for ritual performance, burials, marriages and births, governmental festivals and annual rites. The inner weaving and dyeing office in Nanjing (Nanjing nei zhiranju 南京內織染局) procured textiles for the imperial household, such as the dragon robes, or high-officials' court robes dyed in its partner institution, the outer office (Nanjing wai zhiranju 南京外織染局). The centrally organized institutions coexisted in close connection with a network of locally administered bureaus originally meant to meet an annual quota system providing silks for annual payments: gifts of commendation, patents assigning ranks and positions, tributary silk and silk for imperial feasts etc. These silk products were generally labeled "official" or for state needs (*gongyong* 供用). Production was unified with a preset range of wefts, designs, and patterns. The central state code stipulated an annual delivery and thus officials nicknamed silk manufacture outside the capital "annual production" (*suizao* 歲造). Operating within a traditional silk region, the Ming founder efficiently located that which required intense communication, that is individualized production, next to his court and capital in Nanjing and outsourced standardized production, that is tributary silks and customary ware, simpler to produce and thus presumably requiring less supervision, to the workshops far away.

Convinced of the impossibility (and probably also the inefficiency) of writing, formalizing and circulating experiences and skills – the Ming,

²⁰ Thomas T. Allsen, *Commodity and Exchange in the Mongol Empire: A Cultural History of Islamic Textiles* (Cambridge: Cambridge University Press, 1997), 27–45. The Mongol empire continued production using the system established by the Song state. Institutions seem to have continued to function without any major interruptions.

²¹ Dagmar Schäfer, *Des Kaisers seidene Kleider: Staatliche Seidenmanufakturen in der Ming-Zeit (1368–1644)* (Heidelberg: edition forum, 1998), 118. In Zhejiang province, local weaving and dyeing workshops were located in the districts: Hangzhou, Shaoxing, Yanzhou, Jinjua, Quzhou, Taizhou, Wenzhou, Ningbo, Huzhou and Jiaying; in the directly administered Southern Area (*Nanzhili*) there were workshops in the districts: Zhenjiang, Suzhou, Songjiang, Huizhou, Ningguo and Guangde.

like their predecessors, put their money on imposed migration patterns for the system's technicians and enforced the inheritance of professions to secure transmission of knowledge and skill over time. Tax regulations tied the artisan to the locality. This was a side effect rather than intentional, as most silk production still happened on a subsidiary level. But this regulation also facilitated the managerial control of expert migration. The Ming ruler recognized the disadvantage of tying the artisan to his native soil and thus institutionalized exchange. While some craftsmen served in their indigenous location ('residential craftsmen' *zhuzuo jiang* 住坐匠), others had to migrate within and across systems on rotational schemes ('term craftsmen' *lunban jiang* 輪班匠 and 'settled craftsmen' *cunliu jiang* 存留匠). This was Zhu's solution to secure and at the same time control the circulation of technical know-how within state-owned manufacture, and, as artisans only partially worked for the state, also for the transfer of knowledge from the private to the state sector (the reverse may not have been his intention).

Ming records tell of weavers called by state power to the workshops of the central state in Nanjing so that he (or she) could create the required sample under close supervision. While we can take for granted that the central workshops absorbed skilled personnel regularly without comment, sources frequently indicate officials were not in favor of enforced migration, believing it to be inefficient. The issue of knowledge circulation achieved a new dimension when the third emperor of the Ming and son of Zhu Yuanzhang, Zhu Di 朱棣 (Yongle emperor), gave orders to move his capital to the North. He included the silk workshops, asking his staff to match institutions in Beijing. Weavers, reelers, wadders and those working in the filature refused to move, and when forced, produced inferior quality goods or ran away at the earliest opportunity, partly because they were separated from their families and partly because they had no supplementary source of income. The climate was too dry for the processing of silk. Bringing silk production to Beijing required investment and an interest in technical development. The investment was too high to interest the individual artisan. Official documentation denotes that officials and scholars were also unwilling to support the Yongle emperor, realizing that, from both a state-political and economic perspective, the move was more ideologically motivated than was politically necessary or financially appropriate. The Yongle emperor soon had to regroup. Thus while the central state's silk institutions in Nanjing ran the actual production, those in Beijing started to perform perfunctory and complementary tasks such as dyeing silk or preparing wadding. Sometimes they simply administered supply and

demand and maintained communication with the producing offices in Nanjing.

The Yongle emperor's most significant move, one with lasting consequence was, however, the extension of the silk network to many regions with no expertise or tradition in this sector, so that 40% of the state-owned silk production was located outside the traditional regions of expertise. Here the Ming state's approach to migration as a major instrument for the communication of technical and managerial issues proved to be a difficult impediment, albeit not the only one. The Yongle emperor had ordered this extension mainly in order to circumvent the quota system established by the first emperor. Silk production in regions such as Gansu suffered from a dry climate similar to that in Beijing where it had failed directly under the eyes of the emperor. We know that quite a number of the workshops established by the Yongle emperor never produced a single bolt. Still, he succeeded in his aim to extend the silk network, intensifying production at the traditional centers for silk. The sources on the weaving office of Ningguo district in today's Anhui province illustrate nicely how this happened. An office for the administration and purchase of silk had existed in Ningguo since the Yuan dynasty. Rather than producing, however, it functioned as an official residence for officials dispatched from the central government. A document of the Hongzhi reign period (1488–1505) of the Ming suggests this office bought in the entire quota of silk bolts demanded by the central government in Jiangnan. In the year 1531 officials made an attempt to use the workshop for its intended purpose. But as experienced personnel was lacking, the artisans at the workshop could only produce plain, that is non-patterned and non-dyed, silk bolts (*suduan* 素緞). The available artisans were not trained in the weft of colored or gold threads demanded by the central state. For this reason the official in charge of the Ningguo weaving bureau had to buy numerous articles from the private market in regions with experienced weavers in order to meet the annual quota. And thus private weaving in Suzhou, Hangzhou or Nanjing prospered.²²

Originally dispatched by the emperor and court to promote and monitor production (*duzhi* 督織), the representatives of these later offshoots of the silk network had indeed no personal incentive to promote production in the localities. Considering the low level of expertise and disadvantageous climate conditions, these ventures were costly and doomed to failure. After

²² Lu Quan 魯銓 and Hong Liangji 洪亮吉 (1746–1809), *Ningguo fuzhi* 寧國府志 [Gazetteer of Ningguo prefecture], *Zhongguo difangzhi congshu* 中國方志叢書, Huazhong difang 華中地方 87 (Taipei: Chengwen chubanshe, 1970 [1919] [1815]), 4: 2a, 6: 10b–11a.

all, what did the central government actually expect from these capable scholars once they were dispatched to dishonorably low positions in remote lands, especially when the alternative to throwing good money after bad was to have an excuse for regular annual travels to the vibrant prosperous Jiangnan area, and the urban centers of Nanjing, Suzhou and Hangzhou to commission and purchase their quota of bolts of silk with appropriate sums of silver? Nurtured by a recurring annual demand, private silk manufacture reached new heights of prosperity and soon could produce surpluses used by traders to expand their networks to new territory. From the viewpoint of the state's engagement into silk, the practice of buying up their annually assigned quota in the private markets, however, had some negative effects, causing the "prices to shoot right up to the heavens" (*jiazhi shenggao* 價值昇高) in the traditional centers of silk fabrication. Thus craftsmen became unwilling to serve for the rather mediocre payment provided by the state. By the late fifteenth century an increasing number of officials from the whole range of Yamen in Nanjing urged the central government to take measures so that "the annual quota production, as used to be customary, is manufactured in the localities as originally intended."²³

Taking immediate action, the court decreed in the year 1485, a mere month after the memorandum was submitted:

All regional offices in which a weaving and dyeing bureau has been erected, [from now on] are no longer permitted to collect monies and thus have silk bolts woven with their name or purchased in other places. [...] Punish resistance severely and fix corresponding fines.²⁴

A century after its inception, in the reign of Emperor Shizong 世宗 (1507–67, reign Jiajing 1521–67), the Yongle emperor's idea of an extension of the network of silk production had proven completely inoperable. Even the threat of punishment no longer dissuaded the dispatched civil servants from buying the required quota, or from delivering goods that were unusable or of such poor quality that they had to be discarded. The government, aligning regulations to realities, officially decreed in 1581 the closure of silk manufacture in Jiangxi, He'nan, Shandong and Huguang.

²³ Liu Ji 劉吉 (1427–93) and Xu Pu 徐溥 (1428–99), *Xianzong shilu* 憲宗實錄 [True records of emperor Xianzong], *Ming shilu jiaokan ji* 明實錄校勘記 5 (Taipei: Zhongyang yanjiuyuan lishi yuyuan yanjiusuo, 1962 [1491]), 104: 3a–3b Chenghua 8 (1472), 155: 3b–4a Chenghua 12 (1476).

²⁴ Xu Pu 徐浦, *Da Ming huidian* 大明會典 [Compendium of regulations of the great Ming] (Yangzhou: Jiangsu Guangling guji keyinshe, 1989 [1503, complemented by Shen Shixing 申時行 (1535–1614) in the year 1587]), "Gongjiang'er 工匠二 [Artisans, part two], gongbu 工部 [Ministry of Work]," 21: 10a–10b.

The state did not, however, release the regions from their tax payments, demanding the value of the annual quota production in silver *liang* 兩. For the private weavers in Jiangnan not much had changed, except that now the central state paid for the wares directly. The Ming state's involvement in state-manufacture enacted on the geography of production: the center of silk production shifted from Sichuan to Jiangnan and Zheli. Another essential change happened on the structural level. Kinship organization, that is the principle of familial training and the transmission of knowledge from biological father to son (or through formal adoption), traditionally provided for continuity and improvement within the silk trade. While the Song state used this to their advantage, the Yuan and Ming were the first to institutionalize vertical knowledge transmission within the inheritance system.

Signals and Carriers: Scholars, Artisans and Silk Production

Prior to the tenth century Chinese states had various means of recruiting artisans, from slavery to high official postings. Most dynastic rulers were only interested in production as a way of getting access to the best products. However, when the Northern Song engaged in manufacture directly, the state had to systematically extend their claim to the best in raw materials and artisanal skills.²⁵ Oriented towards scholarly learning, the Northern Song state, rather than including the master craftsman explicitly into their administrative system and thus assigning an official position to him, hired craftsmen labor. The system was called consensual employment (*hegu* 和顧). Recruited on the basis of long-term contracts, this group of salaried artisans (*mujiang* 募匠) formed the main work force of state manufacture from the tenth until the twelfth century. For more provisional needs, officials summoned craftsmen from the guilds (*danghang* 當行) or artisans worked on rotational schemes (*fanhang* 番行). Utilizing craftsman skills for the state, the Song nevertheless refused any further commitment to this class in terms of social status or responsibility, keeping them carefully outside the fields of state power. Insisting on a literary basis for civil service examinations, the Song deepened the trench between representatives of practical and theoretical knowledge with regard to state power.

²⁵ Li Shaoqiang 李紹強 and Xu Jianqing 徐建青, *Zhongguo shougongye jingji tongshi, Ming Qing juan* 中國手工業經濟通史, 明清卷 [Comprehensive history of Chinese handicraft economy, Ming and Qing dynasty] (Fuzhou: Fujian renmin chubanshe, 2004). For the evaluation of the Song dynasty see Dieter Kuhn, *Die Song-Dynastie (960 bis 1279): Eine neue Gesellschaft im Spiegel ihrer Kultur* (Weinheim: Acta Humaniora, 1987), 379–381.

Usurping the Chinese states of the Jin and the Southern Song, the Mongols brought new incentives to Chinese craft culture in the twelfth and thirteenth centuries. As they required craftsmen they redefined farmers' and officials' households as craftsmen's in order to press levy from them (*siguan jianghu* 司官匠戶). Both farmers and scholars often willingly agreed to this change, as the former achieved tax reductions and the latter in this way could avoid political persecution. Binding artisans into a system of socage, the Yuan dynasty did not offer economic freedom to the craftsman. Yet, they respected him. Many artisans could run a decent household with a workshop of their own, and possessed handsome personal assets. And although the Yuan state allowed craftsmen better access to state-relevant sectors than the two states of the Song by appointing them into official and managerial positions, the Mongols' belligerent traditions and ideals were in the foreground of political endeavor. Thus they generally kept craftsmen away from political power. With the introduction of the levy system, the Mongols implanted their social attitudes and ideas about craftsmanship in Chinese culture. They cemented craftsmanship within state manufacture as male labor (it had been women's work well into the Southern Song). Chaining the craftsmen to the state, they also arranged for a perpetuation of disciplinary boundaries set within fields of practical expertise in Chinese traditions.

The Ming dynasty could draw on structures tested by their predecessors, the Song and Yuan dynasties, picking and choosing whatever suited their purpose best. Zhu Yuanzhang decided to reduce the risk of social disturbances. Regulating the period of labor and its implementation within feasible boundaries, he kept the leash much longer than the Mongols who often fully absorbed the craftsmen in their system. Zhu Yuanzhang conscripted craftsmen with hereditary status to a period of service between two to four months, and although this only afforded a relational relief, it meant the craftsmen were more likely to cooperate, because it offered them enough time to work for their own living.²⁶ Seen from the point of view of knowledge transfer, Zhu Yuanzhang's elaborate plan of recruitment imbued the Ming state-owned manufacture with inbuilt channels to communicate knowledge. From now on craftsmen not only traveled to receive training, they regularly spent time 'on the road' to fulfill their obligations. Enrolled as term workers on an annual scheme (*lunban jiang* 輪班匠), they had to travel and do levy service annually in assigned local manufactures. The local registries reveal that weavers from Suzhou, for example, had to work

²⁶ Xu Pu, *Compendium of regulations of the great Ming*, vol. 5, 189: 2567–2568 (2b–3a).

in Hangzhou, Jiaxing or Ningbo; thus bringing the skills and knowledge of Suzhou, the home of one of the most eminent local weaving and dyeing offices, to other regions. And textile workers from Zhenjiang, Wenzhou and Shaoxing had to work in Hangzhou to learn from the local masters of the trade.²⁷

The documents of the early and mid-period of the Ming dynasty have few official complaints about the recruitment of craftsmen. If we assume that no news is good news, we may interpret this as a sign that Zhu Yuanzhang's system worked well for both the craftsmen and the state. During this period, local officials, in the context of installing their bureaus, occasionally refer to recruitment as an issue of knowledge transfer: they propose that craftsmen with special expertise should be ordered to move or complain that arriving artisans lack necessary abilities.²⁸ Officials in Jiaxing ordered brocade weavers from Hangzhou to move to Jiaxing for the same reasons as later, during the Qing, the provincial Chen Hongmou transferred farmers: in order to spread expertise.²⁹ The sources do not reveal the outcome of such measures (whether or not transmission succeeded or the weavers took up permanent residence in these places). But the remarks indicate that the officials acknowledged the craftsmen as the ultimate bearers of knowledge and skills that were only insufficiently transmitted via the written word.

From the mid-fifteenth to the sixteenth century the imperial demand increased both at the qualitative and quantitative level. Accordingly, officials of the central state reported problems. Many of these reports originate from the bureaus' subordinate, and are directed towards the Ministries of Work, Finances and Military (*bingbu* 兵部) who shared the task of managing the labor force for the weaving and dyeing bureaus under the supervision of the central government. The bureaus of industrial prefectures, regional military courts (*dusi yasuo* 都司衙所) and manufactures under local or regional administration were another important unit for the regulation of workforce, mainly dealing with settled craftsmen (*cunliu jiang*) who lived near the centers of state-owned production and delivered their levy on a monthly basis.³⁰ Officials could tie excellent craftsmen closer to the

²⁷ Zhou Kongjiao 周孔教, *Jiangnan shugao* 江南疏稿 [Request to the throne and memoranda from Jiangnan], Nanjing sheng tushuguan Nr. 09NM23776.

²⁸ Xu Pu, *Compendium of regulations of the great Ming*, vol. 5, 201: 2704 (4b).

²⁹ See also article by William Rowe, this volume. Shen Yaozhong 沈堯中, ed., *Jiaxing fuzhi* 嘉興府志 [Gazetteer of Jiaxing prefecture], recompiled by Liu Yingke 劉應鈞, Wanli period, preface 1598 (Taipei: Chengwen chubanshe, 1983), for example, records about such enforced migration of 10 brocade weavers from Hangzhou.

³⁰ At the beginning of the Ming 300,000 households were registered. This is an

state by changing their status from termed workers to settled artisan. This change of status, did, at least on paper, also have benefits for the artisans. In contrast to levied short-term workers, settled artisans received regular payments. Whether these payments were favorable compared to what they could have earned on the free market is not clear.

According to the official statutes, the category of residential craftsmen was restricted to those living in the capital(s) – that is Beijing and Nanjing. They could decide how to serve, with some doing their levy once every two months for 20 days and others serving every month. Conversely the statutes refused to give the state the right to decide on the exact date of recruitment or any prolongation of the term, probably because originally Zhu Yuanzhang saw more need to stabilize the country and the people than to ensure constant access to all domestic goods. Eventually this regulation, however, achieved the status of an ancestral law that officials had to obey at least on the documentary level, even though in practical life they must have organized the periods of levy in some way in order to avoid shortfall or surplus.³¹ The system of corvée labor was in use more or less successfully in Ming China until the introduction in 1530 of the “Single Whip” reforms (*yi tiao bianfa* 一條變法). Both procedural and regionally diverse, these continued throughout the sixteenth century and gradually allowed labor service to be replaced by cash payments, a step which anticipated the more radical move towards paid labor in the late seventeenth century.³² The reform itself did not bring any immediate sweeping changes, partly because its realization took more than fifty years, partly because its edge was softened by continuous political infighting. Its repeal in 1581 simply acknowledged what had long been practice. The

idealized or even artificial number; Luo Lixin 羅麗馨, “Mingdai jiangji renshu zhi kaocha 明代匠籍人數之考察 [Research on the statistics of households and people during the Ming period],” *Shihuo yuekan, fukan* 17, no. 1–2 (1988): 4.

³¹ Xu Pu, *Compendium of regulations of the great Ming*, vol. 5, 189: 1–5. Residential, term and local craftsmen formed the group of civil craftsmen (*guanjiang* 官匠). A totally different group were the military craftsmen (*junjiang* 軍匠). Few of the latter can be found in local manufactures or institutions administered by the Ministry of Work. Most of them served in the production sites of military institutions. It looks as if such emplacements, which were quite regular during the two Song dynasties, became more rare during the Ming, only used in cases of urgent need. In silk manufacture military craftsmen mainly pursued basic tasks. Whether or not their employment also included the enforcement of political control or subduing labor uprisings is not clear.

³² Zhang Tingyu, *History of the Ming*, vol. 7, *juan* 82: 6 (1997) “Shihuo 食貨 [Food and commodities]”. The expression corvée is only an approximation as work in government manufactories was remunerated and thus not corvée labor in the true sense.

single-whip reform, however, generated a rise in the historical visibility of labor markets.³³

Enlisting craftsmen had worked quite well in the first decades. However, its deficiencies were quickly revealed with generational change, when sons proved to be incapable of performing their fathers' craft to the same standard. As Zhu had further decreed the craftsmen had to travel to their assigned workshop at their own expense the levy soon proved to be a heavy financial burden for the individual craftsman. And with private clients, such as the dispatched officials from Gansu, rich merchants and landowners, all competing for the best craftsmen, these were increasingly reluctant to give their best to the state for low returns. Thus the local officials of Hangzhou and Suzhou complained that the masters regularly delivered bad work in order to be freed from their tasks, sent apprentices as substitutes, tried to buy themselves into another household class, or simply fled to escape their duties.³⁴

When they reformed institutions, the Ming state drew considerably on the experience it had gained with the recruitment of labor and materials within the duties of the Weaving Workshop for Short-term Requirement (*gongying jifang* 供應機房) – a bureau that Zhu Yuanzhang had initially institutionalized as a hedge against high variations in demand and supply. Such institutions were also established in the hotspots of the porcelain and ceramic industry. As one of the more considered features within the Ming system, they give evidence of the civil servant's insights into managing silk production. Managing provisional demand and supply, the "Workshop for Short-term Requirement" was designed as an administrative job-agency that additionally handled raw materials to keep an eye on quality (freeing the weavers from the financial burden of purchasing raw silk may not have been the initial aim). Officials of this bureau had more the role of contractors or project managers. They had a list of workers and suppliers whom they could approach with specific jobs. The agency handpicked artisans and paid them well to produce highly individual and superior pieces of silk for the emperor and his court. Partly the artisans worked according to detailed

³³ Kent G. Deng, *The Premodern Chinese Economy: Structural Equilibrium and Capitalist Sterility* (London and New York: Routledge, 1999), 307–310 summarizes the changing politics of the Song state towards monopolies..

³⁴ Luo Lixin 羅麗馨, "Mingdai guan shougongye zuzhi zhong guanjiang de guanli zhidu 明代官手工業組織中官匠的管理制度 [The administrative system for levied craftsman within state-owned manufacture during the Ming dynasty]," *Dalu zazhi* 77, no. 5 (1988): 81.

requests, but most likely the talented among them were given a free hand to produce innovative products of their own devising.³⁵

It is not clear, when the officials of the workshop for short-term requirement stopped negotiating directly with the producers and began using mediators. However, by the single-whip reform when the state ceased silk production outside Zhili and Jiangnan, it was already drawing on a class of expert merchants who either procured raw material for households and then collected the finished product (guaranteed weaving), or funded raw material according to the ordered product. A trend towards privately driven market economy had persisted in Chinese society at least since the emergence of production centers in the Song dynasty, but with this reform a privately owned brokerage system would become honed to an efficient instrument of commerce. By the 1560s, the extended Yongle-system had dispersed completely, with many local institutions vanishing entirely from the scene. The centrally organized institutions within the state-owned system, such as the inner weaving and dyeing bureau in Nanjing and the local weaving and dyeing offices of Suzhou and Hangzhou, however, emerged strengthened from this change. Suzhou and Hangzhou, though not officially freed from the annual quota, in fact exclusively delivered special orders directly conveyed to them by court eunuchs. Similar to the central institutions they were now able to officially recruit and pay the best experts of the trade. Additionally silk officials could now recruit so-called account workshops (*zhangfang* 賬房) that produced within a system of guaranteed buying (*baomai* 包買). How designs were communicated in this network is hard to say. Illustrations may have been used, and weavers may have advertised their repertoires gained through experience and familial heritage with samples, as did painters and embroiderers. In a decade these account workshops matured to major production units in the private sector, feeding the market for commercialized silk textiles. Privately run, these workshops relied on merchant investment. They would persist until the Qing state finally abolished them in the year 1702.³⁶

³⁵ Zhang Juzheng 張居正 and Lü Diaoyang 呂調陽, *Shizong shilu* 世宗實錄 [True records of emperor Shizong], *Ming shilu jiaokan ji* 明實錄校勘記 8–9 (Taipei: Zhongyang yanjiuyuan lishi yuyuan yanjiusuo, 1965 [1577]), 361: 5 Wanli 29, seventh month (1601). *Juan* 172 (1535), second Month *yiyi*, 4a–5b (8406) contains an elaborate catalogue on issues about how to organize work within this framework. For a translation and discussion see Schäfer, *Des Kaisers seidene Kleider*, 142–154.

³⁶ At the same time cloth-milling developed to an independent craft in which, in contrast to the silk sector, leaders (*baotou* 包頭) heading craft associations controlled both the tools and the raw materials; Qian Yong 錢泳 (1759–1844), *Lüyuan conghua* 履園叢話 [Talks on the Worm garden] (Beijing: Zhonghua shuju, 1991), 23: 24–25.

The partial withdrawal of the state from production after 1580 is often seen as a major incentive for the increasing commercialization of the goods market in China during the seventeenth century. It is during this period that the literati reported on open labor markets where craftsmen assembled in the morning to be hired by state officials as well as owners of large workshops. Freed from levy labor, the craftsmen could earn more money on the free market. Yet, for the settled craftsmen it also meant rises in the cost of living, pressure on prices and loss of social security. With the court and gentry increasing their demand for silk throughout the Ming, the supply of silk strands had to be divided between competing users. Although the state could definitely exert political pressure to receive their share, it was often a difficult matter for them to acquire a sufficient supply of raw silk, especially whenever the state itself pushed the quota of its own institutions higher. The raw material was subject to agricultural planning and thus could not be increased at will. Maintaining this difficult balance, the civil sector must have been strong enough to meet demand at short notice by providing both the work force and the material. Administering state-owned silk production the officials had to keep pace with all-important developments, and thus were dependent on a smooth flow of information and knowledge among all involved parties. They could frame the channels through which they wanted the information to flow. The major carrier, however, remained the artisan. Even though the scholar may not have been willing to openly show his respect for craftsman skills, he relied on them. This inherent contradiction challenged the scholar's elite position and role as civil servant of the state. The scholar reacted to this by depicting the craftsman skills as seen in elaborate decoration as immoral, seductive and corrupting. The scholarly denial of the artisan's social role reduced the artisan in the written culture of this era to a shadow in scholarly disguise.

Organizing craftsmen within a technological system and calculating taxes, the state and its servants identified craftsmen as groups or individuals, marked professions, and defined the relation between fields of expertise. Enrolling craftsmen into lists in order to make their knowledge accessible to the state, Song scholar-officials turned their backs on further organizational tasks such as the management of supply and demand, or the selection of expertise and persons to fill temporary assignments. Guilds emerged that soon developed into self-organized bodies, providing the craftsmen with social security and help where the state had no interest. Obtaining a meaningful place in the organization of craft culture, these associations could shape out their idea of fields of expertise and their linkages with less interference from the state than would become the case after the thirteenth century.

The historical records of the Ming allow no systematic overview of the size and type of workforce that the state could actually command. But the records, even if idealized, do reveal a highly differentiated system of labor division in silk manufacture. Ming officials were masters of accounting, recording the supply of materials and workforce in precise detail. The official annals, the *Mingshi* 明史 (History of the Ming), grant insights into the differentiation of work, its segmentation and the fields of expertise within Chinese craft culture. In silk the central state still officially distinguished 230 tasks, ranging from general occupational categories such as weaver, tailor, cloth miller, or smith to specialist tasks such as the stitcher of the goldthreads or the counter of the pearls.³⁷ Not all registers account for a similar level of diversification; partly because not all officials were equally eager in the completion of their duty, and partly because not all fields received equal official attention. In this regard silk production must have been extremely important as almost 30% of the professions registered relate solely to this field.³⁸ Local institutions responsible for actual recruitment listed the minute details of tasks for practical reasons and thus we get a glimpse into the range of professions that became obligatory to silk manufacture: specialist reelers, the draw loom boy (the boy sitting on the pattern tower to draw the weft beam in time) or the people who contrived the pattern mechanism for the complicated weft-based textiles. Whenever premium quality raw material was at stake, specialization was their preferred method. Weavers specialized on a specific loom, such as the waist or draw loom, or on the production of one textile or weft such as damask, or brocade. Others specialized in specific garments or the production of accessories such as hats or girdles. Even the transport of the wares was considered an elementary part of the silk production network, although its organization often went far beyond local responsibilities and capabilities.³⁹ In sum, the range of workers procured for the weaving and dyeing bureaus encompassed every level of the workforce, down to those who constructed, maintained and repaired the buildings. State-owned

³⁷ Luo Lixin, "Research on the statistics of households and people," 7.

³⁸ Luo Lixin, "Administrative system for levied craftsman," 2: 39–41. A report of the weaving of the Qing era work was translated into German by Elke Piontek-Ma, *Der Bericht von Sun Pei über die kaiserliche Seidenmanufaktur von Suzhou im 17. Jahrhundert* (Heidelberg: edition forum, 1999).

³⁹ Cao Shipin 曹時聘 (n.d.) bemoans that any attempt by the government to reconstitute old practices ended by the dyers taking flight; Gu Bingqian 顧秉謙 (1550–1629?) and Ding Shaoshi 丁紹軾, *Shenzong shilu* 神宗實錄 [True records of emperor Shenzong], *Ming shilu jiaokan ji* 明實錄校勘記 11–13 (Taipei: Zhongyang yanjiuyuan lishi yuyuan yanjiusuo, 1966 [1630]), 361: 5 Wanli 29, seventh month (1601).

manufacture in general purchased all materials and never engaged in the agrarian side of silk manufacture.

There is, however, one astonishing lack in this range: not one single weaving and dyeing office, not in the central nor in the local network, employed carpenters or people specialized in constructing, installing or repairing the various looms for the specialized wefts, such as the brocade or tabby loom, the waist loom or the draw loom with pattern tower for complicated warp patterns. The local weaving and dyeing bureau of Jiaxing, for example, lists in its detailed report 72 different professions in the silk manufacture sector in the early Qing, registering altogether 1068 households, which is 20% of all craftsmen households.⁴⁰ But there is no mention of a single specialist for the construction of looms, not even in the lists of its institutional structure. As silk weavers required soft hands, it is unlikely that the weavers themselves accomplished this task. They may have been able to advise the carpenter who was himself considered subject to the carpentry business as early writings such as the *Ziren yizhi* 梓人遺制 (Time-honored institutions of the joiner's craft) of the year 1264 imply. It is likely that the Ming continued this tradition. Nevertheless it is worthwhile noting that documents remain silent on this point.⁴¹ I found only one report in a local monograph that suggests that looms were indeed a separate issue of private economy and remained so even during the Ming dynasty. The local gazetteer notes that looms were produced and sold on the local market and distinguishes looms for different wefts such as tabby looms (*lingji* 綾機), tax-tabby looms (*juanji* 絹機), sha-gaze looms (*shaji* 紗機), luo-gaze looms (*luoji* 羅機), chou-gaze looms (*chouji* 綢機), and cotton looms (*buji* 布機). Yet, all of these are of a rather simple type, whereas the complicated machine of a drawloom with pattern tower (*tihua ji* 提花機) whose construction may have required specialized training is never mentioned in such contexts.⁴²

⁴⁰ The local monograph of Wu Yangxian 吳仰賢 (1821–87), and Xu Yaoguang 許瑤光 (1817–82) documents a total of 5277 craftsmen households in Jiaxing; Wu Yangxian 吳仰賢 and Xu Yaoguang 許瑤光, *Jiaxing fuzhi* 嘉興府志 [Gazetteer of Jiaxing prefecture], *Zhongguo difangzhi congshu* 中國方志叢書, *Huazhong difang* 華中地方 53 (Taipei: Chengwen chubanshe, 1970), “Hukou 戶口 [Household],” 5: 4–8.

⁴¹ Xue Jingshi, *Illustrated primer of the carpenter's customs*, 135–176. The writing was originally compiled by Zhu Qiqian 朱啓鈞 and published by Beijing: *Zhongguo yingzao xueshe*, 1933. For a discussion of the looms described in the *Illustrated primer of the carpenter's customs* see also Kuhn, *Webstühle des Tzu-jen I-chih*.

⁴² *Wu xianzhi* 吳縣志 [Gazetteer of Wu county], ed. Wang Huanru 王煥如 and re-edited by Niu Ruolin 牛若麟, *Tianyige cang Mingdai fangzhi xuankan xubian* 天一閣藏明代方志選刊續編 (Shanghai: Shanghai shudian, 1990 [Chongzhen period (preface 1642)]), “Wuchan 物產 [Products],” 29: 41 *xia* 下.

It is likely that tools and devices were exclusively repaired and constructed in the households by the weavers, or by loosely attached but specialized carpentries. This is a possibility for the pre-Yuan period, when the state largely abstained from interfering into production issues. The fact that such professions do not appear or at least were never singled out by name leads to the interesting assumption that the elite actors and officials managing the state-owned silk production did not consider tool production, whether a complicated loom or a simple mandrel, a sensitive cord in the neural network of silk production.

Wavelengths and Bandwidth: Social Mobility

Managing state-owned manufacture, officials had to organize craftsman expertise, decide which skills were required and where to train them. In this way officials came not only into contact with craftsman, they also judged expertise, and, although they may not have liked it, their engagement influenced their viewpoints, stimulating people such as Wang Yangming 王陽明 (1472–1529) to reconsider the value of intellectual endeavor and describe his thoughts on intuitive learning, or Huang Zongxi 黃宗羲 (1610–95) who cast his eye on issues of practical statecraft.

While such scholarly activities and its relation to practical issues have often been in the focus of research on scientific and technological thinking in China, few historians have asked about the effect that these developments had on the craftsmen's consideration of their status: how did the craftsman, now crucial to the state and involved into its affairs, perceive these changes and adjust to the circumstances? Historical research suggests that social mobility was on the increase by the end of the Ming period. Artisans however, remained below the scholar and farmer, but above the merchants. We furthermore know that scholar-officials refused to allow craftsmen to climb the ladder of success on the basis of their practical skills, insisting on scholarly learning as the sole key to political career and social status. Most scholars suggest that craftsmen wanted to achieve a higher status, and yet can we assume that the scholars' view really reflected the craftsmen's ideals? And even if the craftsman wanted to achieve social status, was the Ming artisan actually pursuing more than that, aiming at entering the realms of scholarly learning? While the artisan may have been glad for any chance to free himself and his clan from the inherited burden of levied service and thus willingly agreed to shift status, it has to be asked if their motives necessarily implied a turning away from their craft.

Texts embedded in scholarly concerns are difficult sources for

the identification of craftsmen.⁴³ Including artisans into official historiography, the biographers attached a scholarly background to practitioners, and depicting scholars, the authors made practical features integral to scholarly personality. This makes it hard to determine which was the initial characteristic. The distinction of craftsmen by household registration is also far from conclusive, because such classifications were the outcome of historical events rather than subject to the identification of professional expertise. Originally from a scholarly background, clans shifted to craftsmen status during the Mongol reign in order to avoid political persecution. Households, as mentioned earlier, unwillingly became victims of the Ming state's perpetuation of the Yuan system. The enactment of Ming state's regulations posed a heavy burden on the family. Rigidly enforcing its system, the Ming state denied clans, despite repeated requests, permission to change back to their original status. Yet, this did not hinder them from participating in civil service examinations. This group must be regarded as scholars, even if the household registry listed them as craftsman.

About 3,5%, i.e. 844 of the 24,184 *jinshi* candidates mentioned by the *Ming Qing like jinshi timing beilu* 明清歷科進士題名碑錄 (Stone inscribed report on the *jinshi* candidates of the Ming and Qing period) are registered under the rubric of craftsmen households.⁴⁴ Some of these *jinshi* presumably belonged to clans with an actual background in craftsmen professions. We know that by the sixteenth century, merchants who had achieved wealth began regularly to encourage some of their descendants to take the exams and pursue official careers in order to gain more social security.⁴⁵ Craftsmen clans who had achieved a degree of wealth from their skills may have done the same. Achieving their rank, they occasionally hid such origins behind scholarly ideals. By the late Ming these scholarly ideals grew so strong that clans completely camouflaged the causative relationship between artisanal skill and official position. And nothing distinguished a craftsmen entering civil service from a civil servant who had achieved his position due to his artisal skills. Family genealogies deliberately highlighted scholarly education and career paths, and stayed quiet about the family's economic grounding in trade or craft enterprises. This bias hides causality, in that a considerable number of the early Ming elite members achieved high governmental positions because they could

⁴³ See Martin Hofmann's article in this volume.

⁴⁴ Ho Ping-Ti 何柄棣, *The Ladder of Success in Imperial China: Aspects of Social Mobility, 1368–1911* (New York: Science editions, 1964), 68.

⁴⁵ Brook, *Confusions of Pleasure*.

construct buildings, bridges and palaces or sculpture bronze statues. Family genealogies, however, also reveal that those still in the status of an artisan by the late Ming only attempted to shift status in cases when their profession became a financial burden. The status of an artisanal household was no hindrance to take the civil service exams, through which Ming elites could achieve official positions and social status. Rather financial constraints, the cost of the appropriate education, seem to have been the limiting factor.

Genealogies provide a glimpse into the contemporary reasoning behind shifts in status.⁴⁶ One local clan of Haining, named Zhu Ding 祝鼎, registered as craftsman for eight generations from the end of Yuan dynasty until the mid-Ming period, and provided officials throughout this time.⁴⁷ During the Yuan dynasty, various family members attempted without success to achieve scholarly status, arguing that they were working for the court.⁴⁸ The local gazetteer of the Ming period depicts Haining as a prosperous district of Hangzhou and a regional center of silk production similar to Qiantang and Renhe. It hosted a commercial tax office (*shuike ju* 稅課局) and a fishing tax office (*hebo ju* 河泊局).⁴⁹ Merchants passed through Haining on their way from the south, via Nanjing, the southern capital, to Beijing, the northern capital. However, during the Ming dynasty the family does not appear to have attempted to change their status. Interestingly during this period the family genealogy abstains from mentioning the actual profession, although a stone inscription listing the same clan name suggests that they worked in the textile sector.⁵⁰ Throughout the Ming dynasty thirty-eight male members of the clan passed the official exams. And in fact many of them received official positions at various levels from that of local teacher up to the level of a Secretary to the left of the Ministry of Works (*gongbu zuo shilang* 工部左師郎), ranked third. In

⁴⁶ Zhang Yuanguo 張元果, *Nanpi Zhang Shi zupu* 南皮張氏祖譜 [Family genealogy of the Zhang clan from Nanpi] (Daoguang 17 (1838)), Yuan lianhebao guoxue wenxian zongxin cang, 2: 21a.

⁴⁷ Yang Jialuo 楊家駱, “Mingdai diwang shixi tu 明代帝王世系圖 [Table of genealogies of emperors and kings of Ming dynasty],” in *Lidai diwang shixi tu* 歷代帝王世系圖 [Table of genealogies of emperors and kings], ed. Gong Shijiong 龔士炯, Zeng ding Zhongguo xueshu mingzhu 增訂中國學術名著 1 (Taipei: Shijie shuju, 1963), 2: 7a, “Liezhuàn 列傳 [Biography],” 11: 1a–1b.

⁴⁸ *Ibid.*, 7: 1a–8b.

⁴⁹ The cities were Guodian 郭店, Yuanhua 袁化, and Zhuantang 轉塘. The circuits Chang’an 長安 and Xiashi 碓石; Fan Shuzhi 樊樹志, *Ming Qing Jiangnan shizhen tanwei* 明清江南市鎮探微 [Survey into the cities and district structure of Jiangnan during the Ming and Qing dynasties] (Shanghai: Fudan daxue chubanshe, 1990), 399–404.

⁵⁰ *Ibid.*, 11: 2–4.

all these cases the family's enrollment as a craftsman household seemed not to have hindered their careers.⁵¹ After the Chenghua period the number of family members taking on official positions increased although they continued to perform their levy duty without complaint up until the mid-sixteenth century, when the first son of the family verifiably requested a shift of status.

The Zhu genealogy is representative in that it shows household registration was a financial issue, rather than a status problem. Originally well planned, corvée labour began to pose a high financial burden to craftsmen in the silk industry when the Ming state and emperors started to manipulate the ancestor's stipulations, which began in the early sixteenth century and climaxed during the prosperous Wanli era. Bargaining over quota was too often at the cost of the craftsmen; they were paid lower wages or had to serve longer without reimbursement. To escape the chains of their inherited status many of them took flight and became wandering homeless (*yumin* 游民). In this disguise they participated in uprisings and social unrest.⁵² While the single whip reform caused state-owned manufacture to recruit craftsmen on a payment basis, it did not stabilize the general situation. Although the levy decreased, the individual artisan now had to compete for work on the free market and the state, identifying the craftsman by his household registration, still often demanded work for little or no money.⁵³ Throughout the Ming period, craftsmen of this group thus had a major incentive to buy themselves into another household class. The scholar class was exempted from all major taxes, farmers had to own land and were still liable to taxation.

The family chronicle of Zhu Ding suggests that financial considerations provided the motivation for a craftsman family's attempts to shift status, not a desire to climb the social ladder or achieve a higher rank. A comparison with the official report indicates that the Zhu were in good company and yet, were infected quite late by a trend that had started much earlier. In the

⁵¹ Ibid., "Xuanju 選舉 [Selected candidates]," 7: 18–20, "Wen Gao zhuan 文鎬傳 [Biography of Wen Gao]," 11: 50 *xia* 下.

⁵² Xia Yuanji 夏原吉 (1366–1430), *Taizu shilu* 太祖實錄 [True Records of emperor Taizu], *Ming shilu jiaokan ji* 明實錄校勘記 1 (Taipei: Zhongyang yanjiuyuan lishi yuyuan yanjiusuo, 1965 [1418]), 159: 4, Hongwu 17 (1384).

⁵³ Xi Shu 席書 (1461–1527) and Zhu Jiaxiang 朱家相 (*jinshi* 1538), *Caochuan zhi* 漕船志 [Record of shipbuilding], *Xuanlang tang congshu* 玄覽堂叢書 9 (Taipei: Guoli Zhongyang tushuguan, 1981 [1544]), 4: 16 *xia* 下. And, Xu Pu, *Compendium of regulations of the great Ming*, "Gongjiang er 工匠二 [Artisans, part two]," 189: 5. According to the *Record of shipbuilding* this form of recruitment had been used long before in the shipbuilding sector. Even local craftsmen, actually pursuing levy service, were paid in order to secure quality; Xi Shu and Zhu Jiaxiang, *Record of shipbuilding*, 6: 8 *shang* 上.

year 1457, officials were already insistently urging the Ministry of Work to force any craftsmen, regardless of which list he was enrolled in, to perform his levy service duty in order to prevent craftsmen from escaping into the scholarly rank.⁵⁴ Apart from a chiseled class-consciousness on the part of the scholar-officials, this complaint suggests that craftsmen continued in their craft, even after a change in status, in order to make their living.

Numerous craftsmen households like that of the Zhu family existed in Zhejiang, Zhili and Fujian. Some family genealogies even explicitly regret the loss of their ability, as was in the case of Xu Zhiniao 徐之孃 (ca. fifteenth century) who mentions that his family, who had long earned their living as ink makers, finally decided to invest their last savings to buy themselves into an official household rank in order to avoid taxes. He did not mention improved social rank as a reason.⁵⁵ While the structure of the Ming-state system had several inbuilt mechanisms of knowledge transfer, these mainly served horizontal rather than vertical transmission. The scheme was not designed to support craftsmen rising in rank due to their ability. In their accounts Ming scholars presumed that craftsmen had to be kept at a distance from political power and social influence within elite culture. Such views had an influence on the possibilities and opportunities available to craftsmen who wanted to improve their status. And yet it looks as if craftsmen, even when attempting to achieve the rank of an official, did not share the scholar's great dream. The fact that members of craftsmen households, despite repeatedly achieving high official ranks, lingered at their lower classification, implies that it was not a hindrance to their career and they did not consider it as such. I suggest that at least some of them originally achieved official ranks because of their practical ability and felt no need to change household classification. Conversely tax exemption may have been just as important a consideration for artisans making the decision to attempt to change status.

⁵⁴ Zhang Zhi 張志, *Haining xianzhi* 海寧縣志 [Gazetteer of Haining county] (Washington: Library of Congress Photoduplication Service, 195– [Jiajing period (1522–66), recompiled by Cai Wan 蔡完]), Microfilm, Guohui tushuguan shezhi Beiping tushuguan shanben shujiaopian 國會圖書館攝製北平圖書館善本書膠片; roll 411, “Shihuo zhi ba 食貨志八 [Food and commodities, part eight],” 5: 14 xia下.

⁵⁵ Jin Dingshou 金鼎壽, *Tongcheng xuxiu xianzhi* 桐城續修縣志 [Continuously revised local gazetteer of Tongcheng county], *Zhongguo difangzhi congshu* 中國方志叢書, *Huazhong difang* 華中地方 242 (Taipei: Chengwen chubanshe, 1975 [1827 (Daoguang 7)]), “Xuanjubiao 選舉表 [Table of selected candidates],” 7: 6a; Qi Xizhou 齊錫周, *Qi shi zongpu* 齊氏宗譜 [Genealogy of the Qi clan], Collected at Yuan lianhe baoguo xue wenxian zhongxin shouzang, 1: 16–17.

Conclusion

An interesting development in the network structure of Chinese technologies is how their evolutionary character balanced efficient state control with a connection to private economy. While most dynastic rulers before the tenth century had relied on market mechanisms, and usually bought the products they required, after the twelfth century Chinese states gradually increased their engagement with production itself. By the fourteenth century the Ming founder Zhu Yuanzhang's profound understanding of craft culture led him to organize silk production within his empire as one of many networks, a complex interlacing of local and central institutions.

As the Ming state was an active player in constructing and developing technological networks, officials developed new managerial skills, acknowledging the challenge to efficiently communicate needs, the supply and demand of raw materials, and expertise. By ensuring supply and demand with a rotational system of levy service and tax payments, the state simultaneously found an outstanding way to provide for a constant knowledge flow among regions, between institutions and presumably also across hierarchies.

Administrative sources show bias in their methods of report, in that they mainly substantiate the hindrance of communication and problems occurring in the production process while staying silent as long as everything functioned and difficulties could be solved without much ado. Looking at the historical records of the three hundred years of Ming reign, I suggest that the technological system of state-owned silk manufacture throughout long periods of the Ming worked out well for both the state and the craftsmen. Including the artifactual evidence, it looks as if the system even increased in qualitative and quantitative efficiency up until the end of the Ming. The complaints that accumulated during some reigns, especially during the long reign of Zhu Yijun 朱翊鈞 (1563–1620, reign Wanli 1573–1620), were caused by the fact that emperors, eunuchs and officials progressively aggrandized their taste for luxury, thus overstraining the system's natural limits of raw material supply and available workforce.

While the institutional framework of state-owned manufacture took care of horizontal transmissibility, it was not explicitly supportive of vertical moves. Scholars, seeing that they required craftsmen to run state-owned manufacture, defined practical knowledge as an individual matter. They closely tied knowledge and skills to the person itself, and in this way authorized their managerial control. On the local level, officials acknowledged craftsmen as bearers of knowledge when they forced experts to move in order to disseminate knowledge, and at the same time

felt justified in keeping them away from higher positions.⁵⁶ The craftsmen, however, as the inquiry into their genealogies demonstrates, may have been less interested in rising to the scholarly ranks than the scholars presumed.

What influence the institutional aggregation of channels of transmission, the separation of working units and knowledge clusters, had on technological development, how these relate to intellectual recognitions of professions and expertise in premodern Chinese society and how both affected each other is still open to research. Chinese elites were concerned about silk production, but never acknowledged loom making as a profession, let alone granted it any special reputation or social standing, even when weaving was drawn out of the household into the public view by the Ming state's engagement. Scholarly writing embarked on the production process and the product, not the machines or the producers. Identifying loom construction traditionally within the carpentry business, the Song, Yuan, Ming and Qing states neglected it, as this investigation has shown, within the institutional organization of state-owned textile processing; consequently linkages between both, albeit necessary to make the system function, were woven at the informal level, – to the extent that the historical account obliterates any association between both sectors. Idiosyncrasies of this kind reveal that technological systems, enfolded into societal needs and cultural ideals, require various levels of connections and connectivity to function smoothly.

⁵⁶ This concurs with the reflections of scholars and officials in private writings as described in the article by Rowe. It also concurs with the Chinese scholarly attempts to embed things and technologies, new and established, into a conclusively coherent narrative, incorporating them into the tradition of *wuyuan*-compilations, (described in Martina Siebert's article), part and parcel of universally valid cultural achievement.